# Science standards Grade 11

## Advanced level

## Scientific enquiry

By the end of Grade 11, students identify, develop and make predictions related to a clearly focused research question. They control variables, work as a team and use appropriate equipment and materials. They evaluate experimental design, identify weaknesses and develop realistic strategies for improvement. They work in an ethical manner. They understand the historical development of major ideas, through the evolution of competing models, and know that science can generate controversies, which they take part in. They record and process raw data appropriately and draw valid conclusions, allowing for errors and uncertainties. They handle equipment competently with due regard for safety. They follow instructions accurately but are able to adapt to unforeseen circumstances.

### Students should:

#### 1 Use methods of scientific investigation

1.1 Identify and develop a clearly focused research question.

Compare the tar content of different brands of cigarette.

Investigate whether the number of chromosomes of an organism is linked features such as body size or sensitivity.

Investigate factors limiting the rate of photosynthesis.

Determine how wind speed influences the rate of transpiration of a leafy plant.

Determine the percentage of sodium bicarbonate in a sample of baking powder.

Investigate the effect of different concentrations of sulfur dioxide on growing plants.

Design an experiment to show that the time taken by an object to drop is independent of its mass under conditions of negligible air resistance.

Design experiments to measure the power output of a muscle under varying conditions.

Compare the insulating properties of different roof materials and structures.

Demonstrate that infrared radiation is reflected and refracted in the same way as light.

1.2 Make predictions directly related to a research question.

Predict relationships between lung capacity and body size.

Predict the progeny of a genetic cross.

Use modelling to predict changes in population density in predator–prey relationships.

Predict whether heat will be reflected and refracted in the same way as light.

Predict the output a given logic circuit.

1.3 Identify and control variables.

Investigate the effect of exercise on the heart rates of people of different size.

Investigate the rate of osmosis between solutions of different concentration.

Investigate the rate of photosynthesis of an algal culture at different light intensities.

Investigate the effect of different concentrations of sulfur dioxide on growing plants.

Design experiments to measure the power output of a muscle under varying conditions.

1.4 Work constructively and adaptively with others as a team on a scientific investigation.

Form teams to carry out a field study of seashore plants.

Work as a team to investigate the inheritance of selected characteristics of fruit flies.

Work as a team to investigate and explain the incidence of colour blindness in a community.

Work as a class to compare the power output of muscles.

1.5 Evaluate experimental design, identify weaknesses and develop realistic strategies for improvement.

Devise a way of determining the impact of humans on a selected habitat.

Develop and evaluate an experimental design to track the impact of humans on an area of desert.

Design an experiment to measure the rate of translocation in a green plant.

Develop an effective way of making soap by traditional methods.

Devise an effective way to compare fairly the insulating properties of different materials.

1.6 Work in an ethical manner with regard to acknowledging data sources and authenticity of results.

Interview people about their smoking habitats and present the data in a newspaper article.

Use published literature to find out the amount of selected yeast-based products produced annually in Qatar and in some other countries.

Write an illustrated report on the structure and function of chloroplasts.

Make a picture display of areas of Qatar that have been affected by industrialisation to illustrate positive and negative impacts.

Obtain information on fertiliser use over time from the Internet.

1.7 Work in an ethical manner with regard to living things and the environment.

Develop ethical guidelines to be followed when doing biological fieldwork.

Carry out a survey of the habitats on a rocky shore to determine human impact.

Study the inheritance of characteristics of mice.

1.8 Identify, and make critical use of, secondary information.

Consult reports to compare the levels of lung cancer in Qatar and neighbouring countries.

Request information on the amount of sewage processed by sewage works in different areas of Qatar and account for the data.

Search the Internet for examples of genetically modified plants and their usefulness.

Obtain information on fertiliser use over time from the Internet.

Study material related to the Bhopal disaster.

#### 2 Know how scientists work

2.1 Understand the historical development of the major scientific ideas.

Study the development of the understanding of mutations.

Study the development of the genetic basis of inheritance.

Make a video on the work of Mendel.

Research the development of theories of translocation.

Study the quest for an artificial nitrogenous fertiliser in agriculture.

Study the development of our understanding of the phenomenon of radioactivity.

Study the development of our understanding of the nature of the electron.

2.2 Know that many scientific topics are controversial, causing debates both between scientists and also among the general public, and be able to take part in such debates in an informed manner.

Debate the theory of evolution by natural selection.

Research and debate different explanations for the increased numbers of people with asthma.

Present evidence related to the possible effects of passive smoking.

Evaluate the correctness of the science in media reports of transgenic organisms.

Debate the use of renewable versus fossil fuels.

Debate the desirability of increasing our use of nuclear energy.

2.3 Know that scientists work by building conceptual models that can be tested by experiment, and realise the value of controversy around competing models.

Find out why the Krebs cycle is so named.

Study the development of competing models of atomic structure and chemical bonding.

Study the development of our understanding of the nature of the electron, from a wave to a particle to wave–particle duality.

2.4 Know how scientific work is affected by its economic, social, cultural, moral and spiritual contexts.

Debate the cultural, ethical and moral constraints placed by societies on contentious scientific research (e.g. genetic manipulation and gene cloning).

Identify major scientific developments that have arisen from national needs (e.g. Germany’s need for a local source of fertiliser in 1914, the ‘space race’ of the late twentieth century).

2.5 Show an understanding of the power and limitations of science in addressing industrial, social and environmental questions.

Make a list of ways in which science can help stem the HIV/AIDS pandemic and a second list of problems associated with HIV/AIDS that science cannot resolve.

Discuss the reasons why, although we understand the biochemistry of human reproduction, some areas of the world are overpopulated and have an increasing birth rate.

See Standard 24.21

Debate issues around the deliberate and accidental release of harmful chemicals into the environment.

#### 3 Process and communicate information

3.1 Record raw data appropriately in a manner that allows easy interpretation.

Prepare charts to illustrate differences in tidal volume and lung capacity and whether this differs with chest size.

Draw diagrams to illustrate the inheritance of alleles through generations.

Construct tables to describe the key characteristics of animals in different phyla.

Make large labelled diagrams of xylem and phloem cells .

Use graphical extrapolation to show absolute zero.

Use multiflash photography to illustrate the acceleration of a falling ball.

3.2 Process raw data by the most appropriate means.

Graph data on the rate of photosynthesis in relation to temperature at different light intensities.

Collect data on people living with HIV/AIDS in different countries and present as percentages of population and as numbers per unit area of the country.

Draw conclusions on the half-life of radioisotopes using a graphical method.

3.3 Draw valid conclusions, allowing for errors and uncertainties.

Rework the data on Mendel's experiments with peas and discuss the certainty of the conclusions.

Understand the importance of multiple readings of radioactive disintegrations to arrive at a statistical average.

3.4 Use an appropriate range of methods to communicate scientific information.

Write a magazine article aimed at alerting young people to the health risks of smoking.

Use models to show mechanisms such as the structure of phloem and xylem.

Create a PowerPoint presentation about homeostasis.

Use models to show organic molecular structures.

Use flow charts to show industrial processes.

#### 4 Handle equipment and make measurements

4.1 Select and use correctly and competently the appropriate equipment and materials for an investigation, with due regard for the safety of self and others.

Use a potometer to investigate transpiration.

Use a spirometer to measure lung capacity and tidal volume.

Use an oxygen meter in the study of photosynthesis.

Use a razor blade to cut sections and make slides of plant stems and leaves.

Use an oscilloscope to study alternating current and induced voltages.

Carry out work with radioactive materials safely.

4.2 Follow instructions accurately but be able to adapt to unforeseen circumstances.

For Grade 11, advanced level, the weightings of the assessment objectives to be applied to each content strand are as follows:

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| --- | --- | --- | --- |
|  | Knowledge and understanding | Application, analysis and evaluation | Scientific enquiry skills and procedures |
| Assessment weighting | 45 to 55% | 25 to 35% | 20 to 25% |